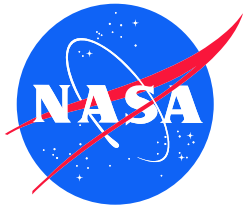

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Space Administration

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Whole Earth Spectra with the Atmospheric Infrared Sounder

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1 Abstract

We are investigating mid-IR spectra of Earth obtained by the Atmospheric Infrared Sounder (AIRS) instrument on-board the AQUA spacecraft to explore the characteristics that may someday be observed in other planets with the Terrestrial Planet Finder (TPF). We will use the spectra to construct directly observed high resolution spectra of the only known life bearing planet, Earth. The AIRS spectra are the first directly observed whole Earth high resolution infrared spectra (R $\sim$ 1200; 3.75-15.4 microns) that span the seasons. Since the AIRS also provides spatial information, we can combine the spectra to simulate spectra of other planets that might be observed with the Terrestrial Planet Finder (TPF) or Darwin. We will also use the 4 Visible/Near-Infrared Channels of AIRS to investigate the range of vegetation signatures that might be observed in the visible and search for any additional correlations at infrared wavelengths.

- The AIRS was put into a polar Sun synchronous orbit on-board the AQUA spacecraft with a 1:30 PM ascending equator crossing time. The spectra are obtained as the AIRS scans across the satellite's path from $\sim$ -49° to +49° about nadir.
- The AIRS obtains 2,916,000 spectra of Earth every day. Each spectrum surveys a $\sim$ 1.1° field-of-view "footprint" ($\sim$ 13.5 km at nadir).
- The AIRS has 2378 Infrared channels in the wavelength range from 3.75 μm to 15.4 μm ($\lambda/\delta\lambda \sim 1200$).
- The AIRS also has 4 visible/near-Infrared channels (0.41–0.44 μm; 0.58–0.68 μm; 0.71–0.92 μm; 0.49–0.94 μm).
- The AIRS is able to observe the entire Earth from space and provide a rich set of spectra consisting of day, night, land, ocean views at all latitudes.

3 Research Objectives

The AIRS data can provide **real** examples of the parameter space that can be explored by the TPF, should it observe an Earth-like planet in the mid-infrared or the visible. AIRS has shown that even the spectra of Earth can display a large degree of diversity (Figure 5). The AIRS data display many of the features that may also be seen in the spectra of other planets by the TPF (e.g., CO_2, H_2O, O_3, NH_4, N_2O, CO). Figure 6 displays and example of a whole Earth spectrum obtained from 3 days of AIRS data.

The AIRS data also enable us to directly observe the flux variations might be observed given an array of viewing angles, cloud fractions, and land/sea fractions.

4 Acknowledgments

This material is based upon work supported by the National Aeronautics and Space Administration under a grant issued through the Terrestrial Planet Finder Foundation Science Mission.

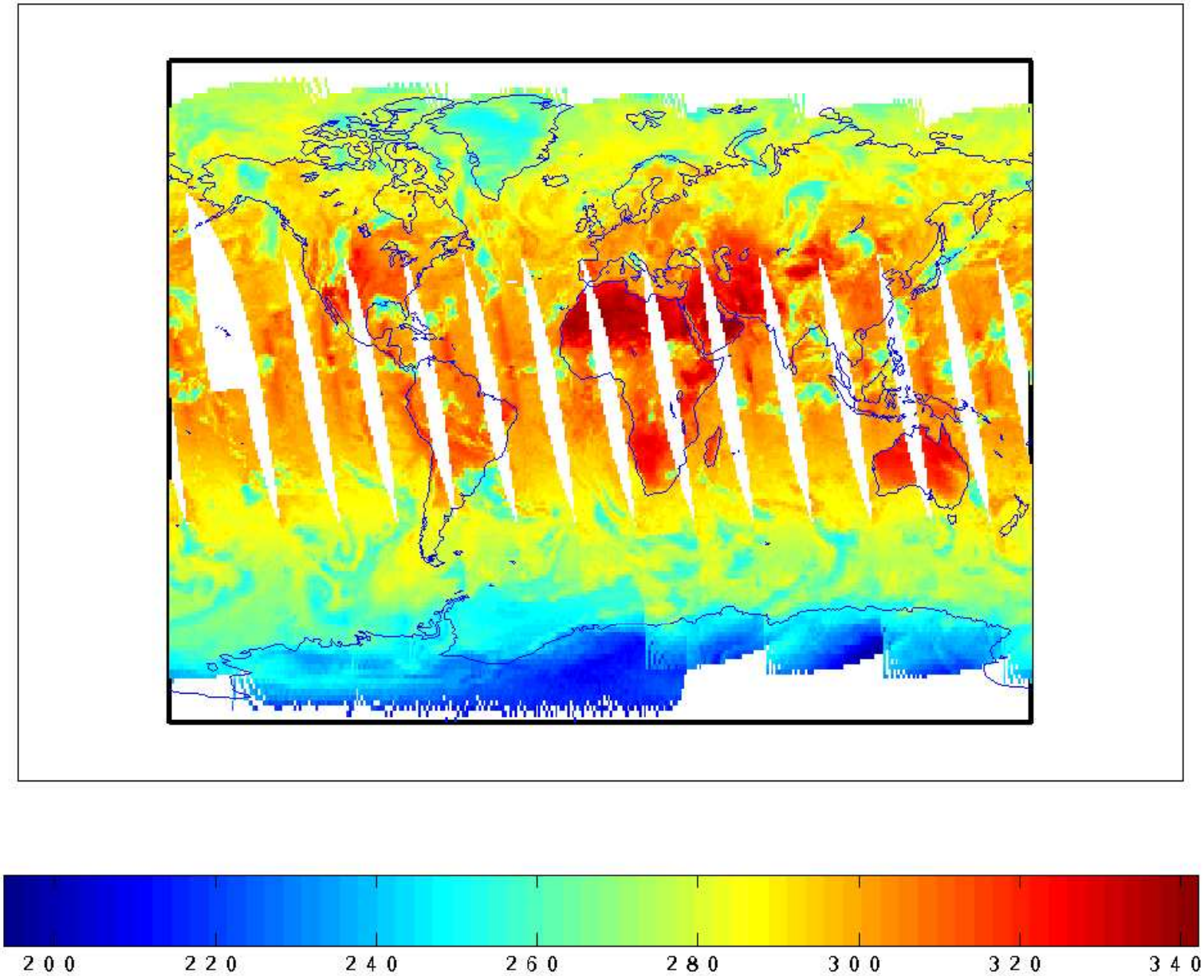

Figure 1: The figure displays an AIRS brightness temperature image for the 3.82 μm "window" channel (2616 cm^{-1}) for the ascending (daytime) nodes on September 6, 2002.

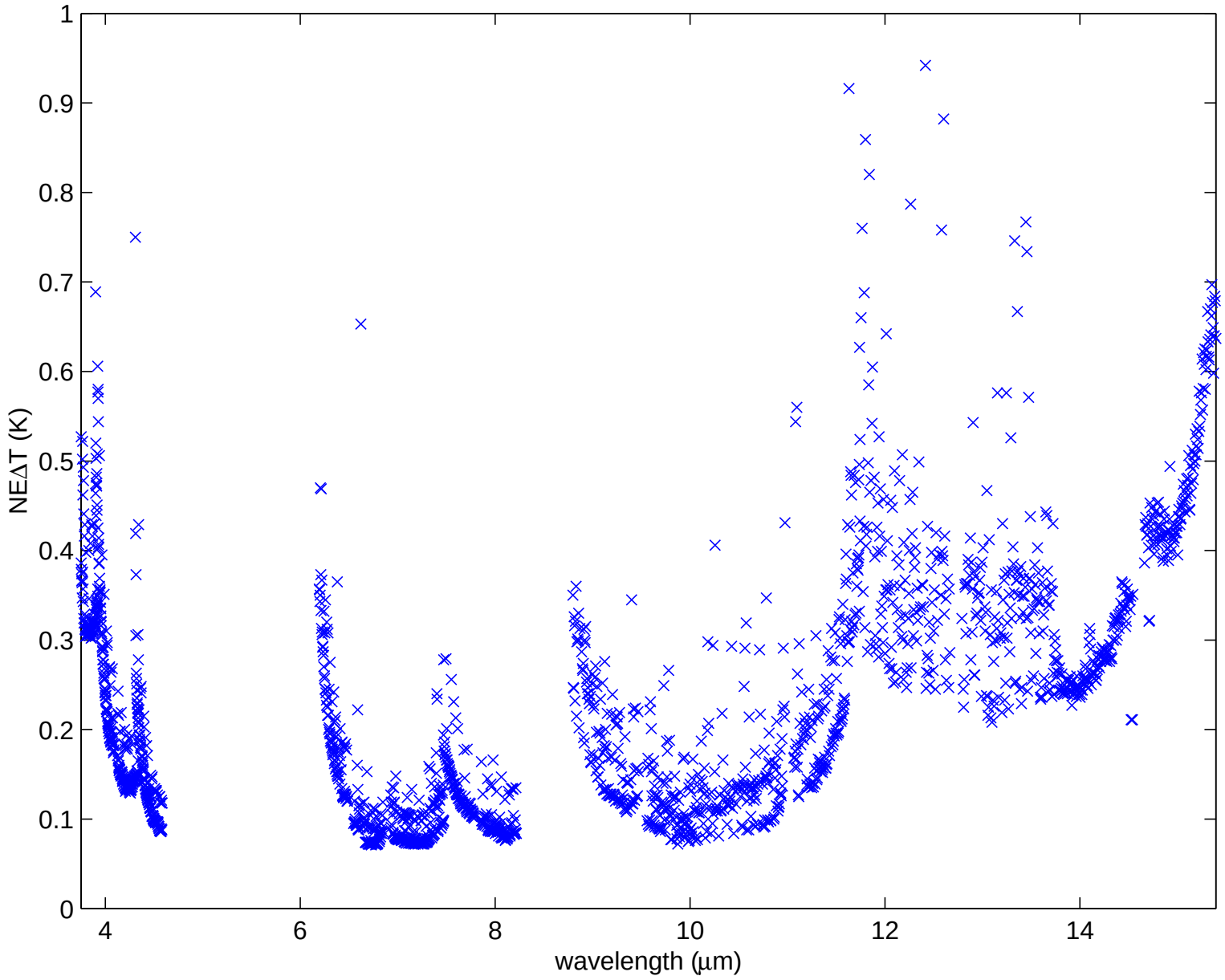

Figure 2: This figure displays the radiometric sensitvity of AIRS in temperature units.

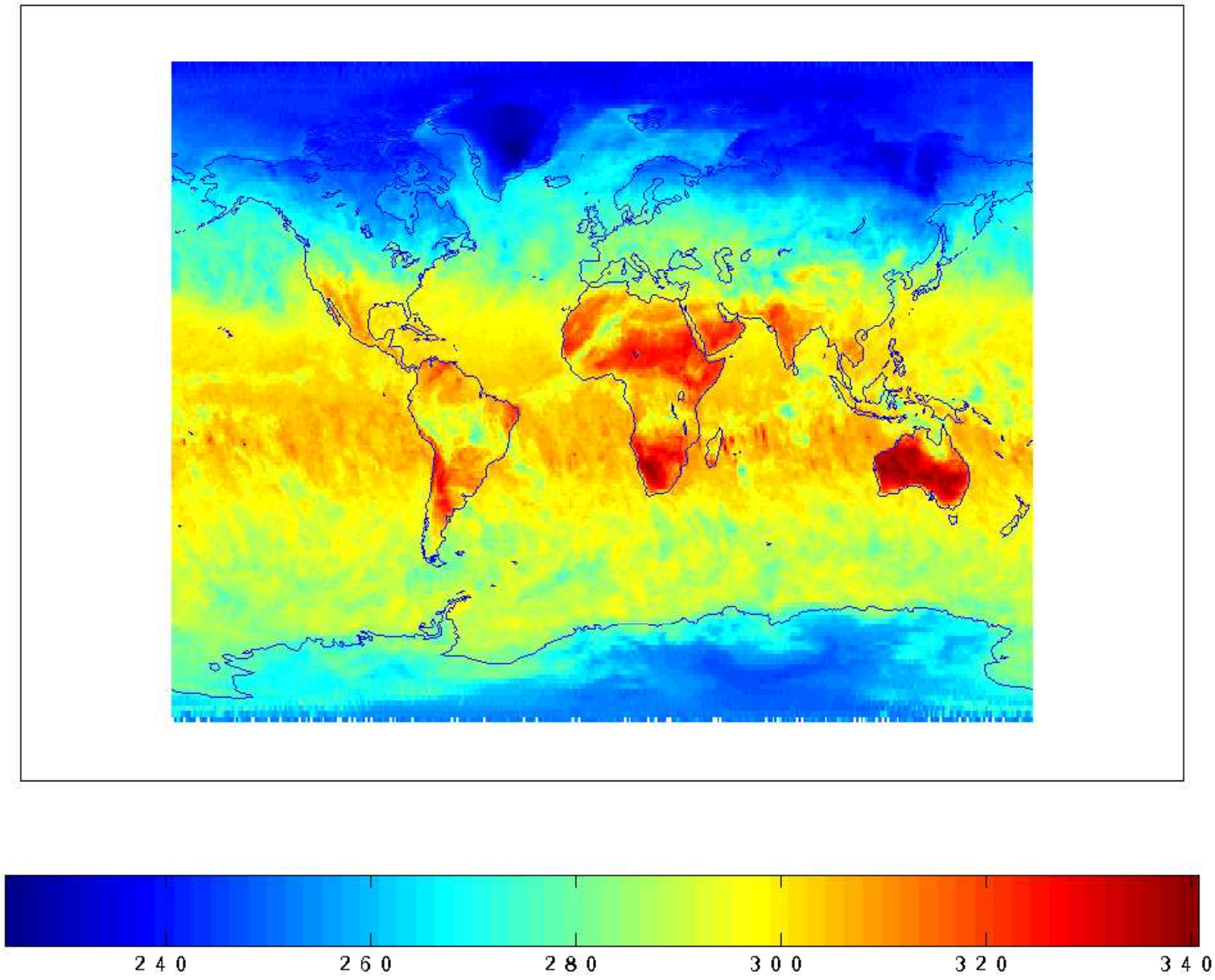

Figure 3: The figure displays an AIRS brightness temperature image for the 3.82 μm "window" channel (2616 cm^{-1} averaged over 1 week (January 15-21, 2003) for the ascending parts of the orbits.

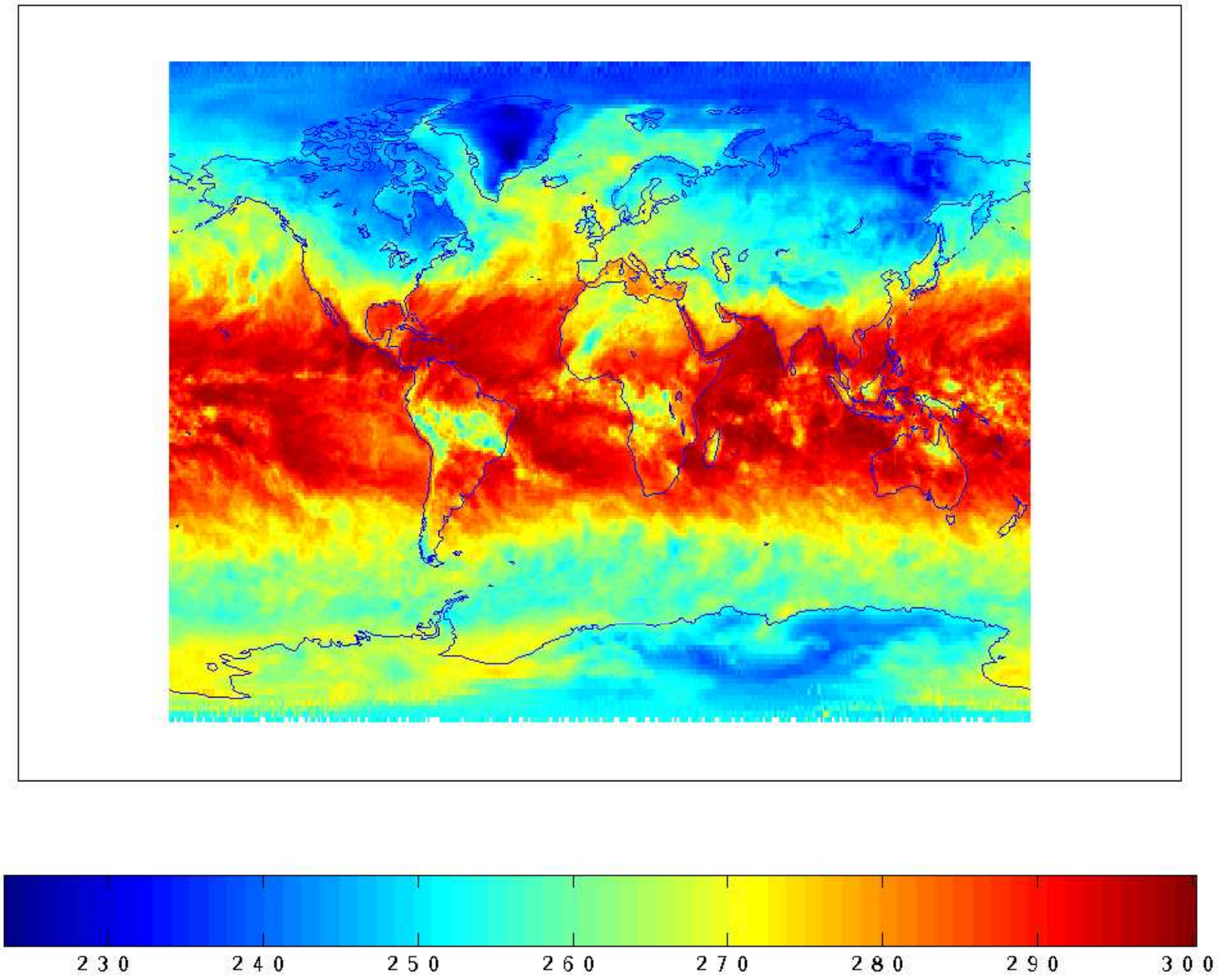

Figure 4: The figure displays an AIRS brightness temperature image averaged over 1 week (January 15-21, 2003) for the descending parts of the orbit.

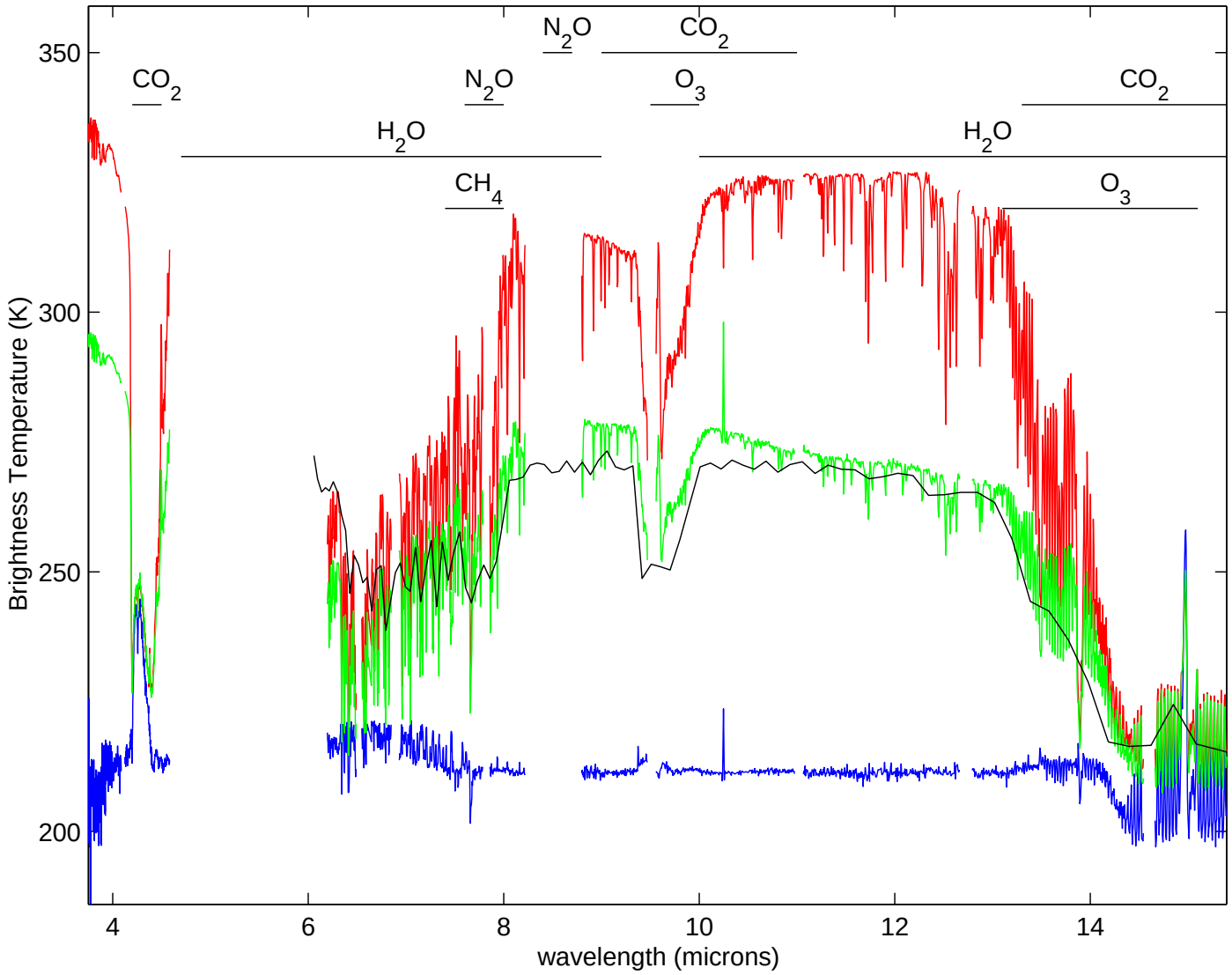

Figure 5: Three AIRS spectra from September 6th, 2002 are displayed to illustrate the diversity of Earth spectra. The warmest spectrum (red) is of the daytime Sahara, the next cooler spectrum (green) is the daytime pacific near the equator, and the coldest spectrum (blue) is of Antarctica. The black spectrum was obtained with the TES instrument on-board the Mars global surveyor.

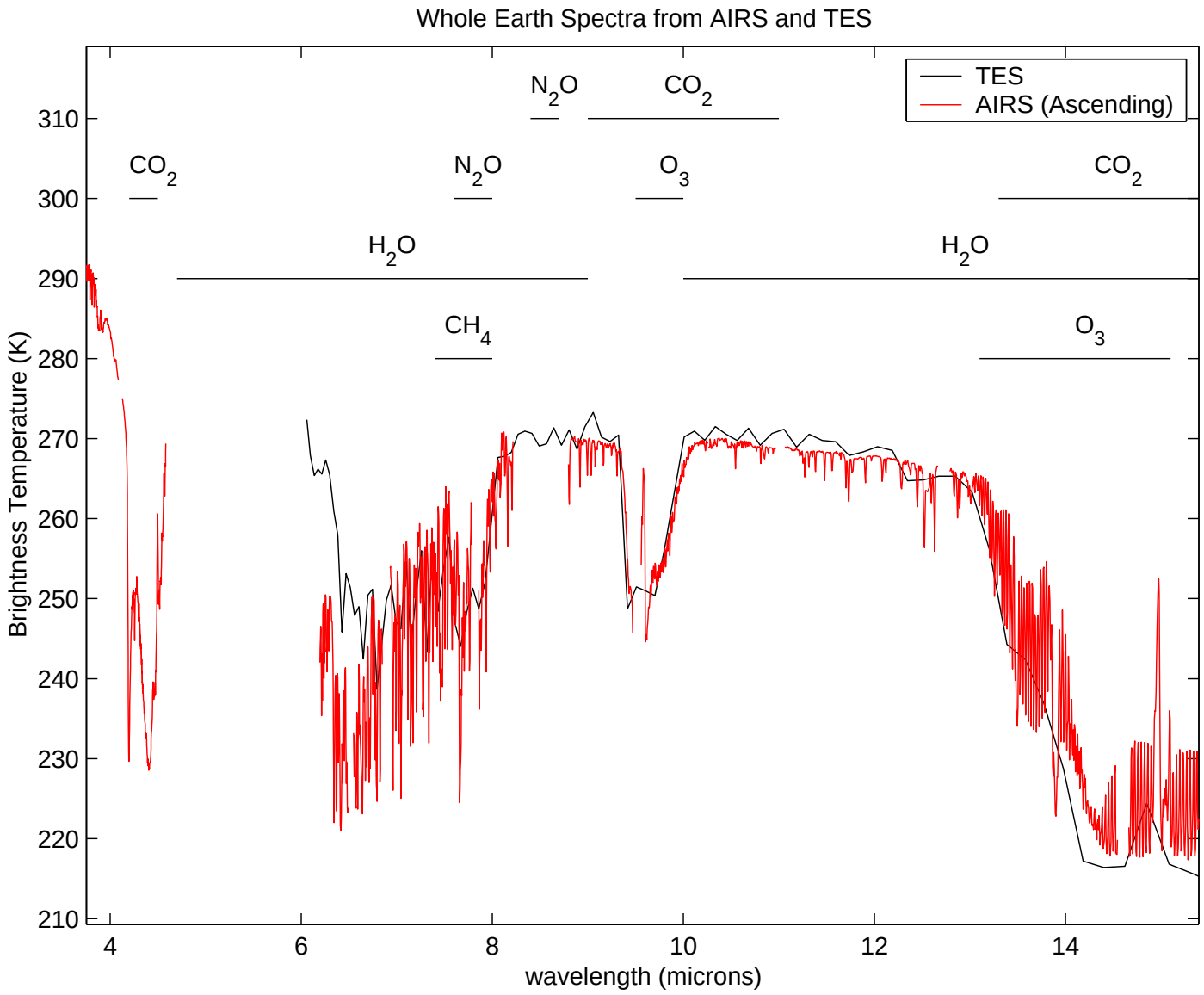

Figure 6: The mean daytime spectrum of Earth over a 3 day period is displayed as it would be seen by a distant observer looking at Earth "edge-on." We also display a spectrum of Earth obtained with the TES instrument.